Wavelength Modulated Differential Photothermal Radiometry: a Thermophysical Spectroscopic Method for Ultrasensitive Glucose Detection in Fluids

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A differential thermophysical spectroscopic method, Wavelength-Modulated Differential Photothermal Radiometry (WM-DPTR), has been developed theoretically and experimentally for non-invasive, non-contact biological analyte detection, such as blood glucose monitoring [1]. WM-DPTR features analyte specificity and sensitivity by combining laser excitation by two out-of-phase modulated beams at wavelengths near the peak and the baseline of a prominent and isolated mid-IR analyte absorption band (here the carbon-oxygen-carbon bond in the pyran ring of the glucose molecule). A theoretical photothermal model of WM-DPTR signal generation and detection has been developed. Simulation results on water-glucose phantoms with the human blood-range, 0-300 mg/dl, glucose concentration demonstrated high sensitivity and resolution to meet wide clinical detection requirements. The model has also been validated by experimental data of the glucose-water system obtained using WM-DPTR.